

Modern Machine Shop

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Bringing Anodizing In-House

What's it going to cost? How much space do I need? What environmental hassles will I encounter? How steep is the learning curve? Exactly what is anodizing? Here are answers to preliminary questions shops have about bringing anodizing in-house.

[#titaniummachining](#) [#basics](#)



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Shops commonly outsource non-machining operations because the envisioned cost and learning curve make it seemingly impractical to bring those processes in-house. They'd rather leave heat treating, laser welding and other such processes to vendors with the expertise and the right equipment, and concentrate on their core competency—machining good parts.

Anodizing is a process that shops often outsource because of these reasons. In addition, it is likely that they are unsure about the anodizing process itself as well as regulatory, safety and environmental issues (some of which vary from state to state). That said, shops can realize considerable cost savings by bringing anodizing in-house. In doing so, they will gain direct control over quality and delivery time while alleviating logistics headaches, too.

So, how do shops know if adding anodizing is right for their situation? One way to determine this is to contact designers and builders of anodizing systems. IPEC Global (Ontario, California) is one such company. Ken Emilio, company president and CEO, has owned and operated machine shops for years and has created a number of anodizing lines for shops. The information he provides in this article offers an overview of anodizing fundamentals along with practical information for shops that may be at the very early stages of anodizing investigation. Although this article isn't meant to be a "how-to" piece, it does answer initial questions shops often have about the feasibility of adding anodizing to their list of manufacturing capabilities.

What Is Anodizing?

Anodizing is an electrochemical process that speeds the natural oxidation of select non-ferrous materials. It improves material surface hardness and wear resistance, and it allows users to manipulate oxidation thickness. Aluminum and titanium are the two most common materials shops are likely to encounter that require anodizing. Anodized components are used for a variety of military, medical, commercial and automotive

aftermarket applications.

Anodizing also enables users to change a part's color using dyes (in the case of aluminum) or manipulating electrochemical parameters (for titanium). For some applications, this color may be simply for aesthetics. For others, such as medical devices, specific colors are chosen for identification purposes. The color of a medical screw, as an example, may dictate the screw's thread dimension and diameter. This color coding also helps with inventory control, making it unnecessary for hospital employees to be familiar with fastener nomenclature or dimensional identification.

There are three types of aluminum anodizing. Type I anodizing, which uses a chromic-acid-based chemical bath, is commonly used for applications that require a thin, protective coating and a high level of corrosion resistance. It also serves as an effective primer prior to painting or other coating operations.

Type II anodizing is the most common and often the most affordable aluminum anodizing process to bring in-house. It is used on a wide variety of applications and enables parts to be dyed in virtually any color. It is based on a sulfuric-acid chemical bath.

Type III anodizing is known as hard-coat anodizing. It is used when a very hard surface is needed, such as for weapons, sporting goods and bearing surfaces. Type III anodized parts typically aren't dyed. Rather, shades of gray are achieved by altering temperature, voltage and bath compositions.

Should Shops Anodize?

To gage the appropriateness of adding anodizing, a shop should first calculate the amount it currently spends outsourcing anodizing. If that cost is less than \$10,000 per year, then it's generally a good idea to continue using the vendor as long as that vendor is dependable.

If anodizing costs as much as \$50,000 per year, then installing a small, modular anodizing line makes sense. These prefabricated systems look like a series of in-line washing machines, and have all necessary tanks, ventilation and closed-loop, rinse-water recycling systems. These units range in price from \$30,000 to \$75,000. Securing requisite permits for these units typically is not a challenge because the chemical volumes are relatively low and spill containment and fume control are often built into the unit. Such modular anodizing lines are suited for small quantities of parts as large as 2 cubic feet, and typically have a footprint of approximately 20 feet by 8 feet. Part racks are moved manually from tank to tank with these small modular systems.

If anodizing costs \$150,000 or more, then a medium- or large-scale modular anodizing line may be appropriate. These systems sometimes use a hoist to move part racks from tank to tank. Prices range from \$100,000 to \$150,000, and it's recommended that shops contact an anodizing consultant to help plan line design and develop operation manuals

Modular anodizing systems generally aren't recommended if a shop's annual anodizing cost exceeds \$250,000. The tanks, pollution control and other related equipment will be significantly larger. Although lines of this type might cost between \$250,000 to \$500,000, an anodizing cost savings of 50 to 60 percent is possible. In this case, an anodizing expert should certainly be used to develop a preliminary line design before a shop solicits estimates from equipment suppliers.

Steps In Anodizing Aluminum

Parts must be immersed in a number of baths before and after the actual anodizing process. Each bath has a specific temperature, chemical concentration and immersion time that must be monitored and maintained. Proper rinsing after every support bath is essential. What follows are the typical steps for Type II anodizing of aluminum alloys.

Alkaline clean—Alkaline cleaning is often the first anodizing step. This bath is designed to remove grease and oils from parts without etching the parts or removing material.

Alkaline cleaning is typically followed by a rinsing bath.

Alkaline etch—This bath removes oxides and gives the parts a smooth, matte finish. An etch bath is not required when a brilliant shine is desired at the end of the process. Etch baths should be followed by vigorous rinsing.

De-smut—The de-smut/de-oxidizer bath removes the dark smut created by the etch bath and is a critical step prior to anodizing. De-smut stations usually use nitric-acid or ferrous-sulfate baths.

Bright dip—The bright anodizing bath, typically of concentrated nitric acid, ultimately shines and protects the part surface. This bath does emit large volumes of nitrogen oxide fumes, however, so proper ventilation is essential. Anodizing in high volumes can require scrubbers to clean these fumes before they are released into the atmosphere.

Color—A wide variety of different colors and color patterns are possible in a dye bath.

Seal—Anodized aluminum surfaces require sealing to eliminate color fading or running. Some sealers include sodium dichromate for added corrosion resistance.

Safety

Operating an anodizing line is similar to operating aqueous cleaning, deburring and vibratory finishing tools. That said, anodizing uses hazardous chemicals so worker safety is paramount. The types of hazardous materials shops will need to purchase, use and store include sodium hydroxide, chromic acid (for Type I anodizing), sulfuric acid (for Type II and III anodizing), nitric acid, ferrous sulfate, nickel acetate and organic dyestuffs. Obviously employees should be outfitted with the proper protective gear. For information about handling these materials, shops should contact their state's department of environmental quality.

In addition to hazardous chemicals, anodizing also generates hazardous waste. This includes diluted wastes such as rinse water and concentrated wastes from cleaner tanks that need to be removed.

Two other areas of concern are wastewater discharge and air-pollution control. The wastewater from rinsing can be recycled or sent to the sewer if local regulations are met. Adequate ventilation is also necessary. Most modular anodizing units have integral ventilation hoods. Anodizing fumes must be exhausted outside the facility, so a corrosion-resistant exhaust fan and ducting are needed. Type I anodizing emits chromic-acid fumes and most government agencies will require a fume scrubber. Scrubbers may not be required for Type II or III anodizing.

Regulatory And Environmental Issues

Many times the regulation process depends upon the number and size of the anodizing lines. Modular, self-contained lines are generally easier to permit than large lines. Shops considering a large line should plan on spending more time and money on engineering and permits.

In many cities permits are submitted to the local fire department for final approval. Fire codes tend to focus on chemical containment and storage in addition to fume exhaust, ventilation and fire sprinkler systems. In cases of large anodizing lines, some fire departments require an extensive ventilation system with emergency generators and fire sprinklers installed within the duct work. This most likely will not be required for small anodizing systems.

Expect Some Frustration

Shops should expect problems during the learning, installation and start-up phases. For instance, it may be difficult to locate a chemical supplier in the area. Shops may also need to purchase anodizing racks or masking materials outside of their state. Simply put, anodizing lines, even small ones, are not “plug-and-play.” However, investing time and effort early in the planning stage will result in an anodizing process that is as effective as it is easy to maintain and operate.

Anodizing Titanium And Part Size Considerations

The titanium anodizing process does not involve hazardous chemicals for most applications. Plus, it is affordable. Modular titanium anodizing systems range from \$15,000 to \$30,000. As with all metal finishing operations, the surface characteristics of the base metal determines the final outcome of the finish. Polishing may be performed prior to anodizing when a brilliant surface is required. After an initial cleaning step, titanium parts are immersed in one of a variety of solutions for anodizing—the transfer of direct current between an anode and cathode. This transfer of current between anode and cathode in the bath creates the oxide film on the surface of the parts. The oxide film refracts light in much the same way a thin film of oil refracts light in water. The thickness of the oxide film can be varied by increasing the DC voltage, thus allowing an operator to dial-in a specific color. Unlike aluminum anodizing, titanium anodizing does not require color dyes or sealers.

What About Part Size?

Part size is another factor in determining if anodizing is appropriate for your shop. In some cases you may want to outsource large big parts and process smaller ones in-house.

Here are common steps for Type II dyed anodizing of 6061-T6 aluminum (actual dwell times and chemical bath concentrations will vary).

1. Soak parts in a heated bath (160°F) of sodium hydroxide (approximately 5 percent concentration) for 1 to 5 minutes. An additive in this bath prevents the sodium hydroxide from etching the aluminum.
2. Rinse with tap or deionized water for 30 seconds to 1 minute.
3. Caustic etch in a heated bath (160°F) of sodium hydroxide (5 percent concentration) for 30 seconds to to 1 minute.
4. Rinse with tap or deionized water for 30 seconds to 1 minute.
5. De-smut using nitric acid at a concentration of 20 to 30 percent, a chromic/sulfuric bath at 5 percent concentration or a proprietary baths based upon ferrous sulfate. Bath times may range from 1 to 3 minutes or longer.
6. Rinse with tap or deionized water for 30 seconds to 1 minute.
7. Anodize in a 70°F bath of 12 percent sulfuric acid for 15 to 60 minutes.
8. Rinse with tap or deionized water for 30 seconds to 1 minute.
9. Colored dye in a 160°F bath of organic dyestuff. Total bath time can range from 5 to 30 minutes depending on the desired color and oxidation thickness.

10. Depending on the application, an additional rinse bath may be necessary.
11. Color seal with a 190°F bath of nickel acetate for 15 to 60 minutes.
12. Rinse in deionized water or a clear seal at 190°F for 5 to 15 minutes.

RESOURCES



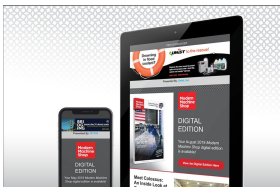
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